Docket No.: 50023-208 **PATENT**

**IN THE UNITED STATES PATENT AND TRADEMARK OFFICE**

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| In re Application of | : | Customer Number: 20277 |
| Hiroshi IKEDA, et al. | : | |
| Serial No.: | : | Group Art Unit: |
| Filed: July 30, 2003 | : | Examiner: |
| For: POWER LINE CARRIER SYSTEM | : | |

## CLAIM OF PRIORITY

Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Sir:

In accordance with the provisions of 35 U.S.C. 119, Applicants hereby claim the priority of:

**Japanese Patent Application No. 2002-222956, filed July 31, 2002**

cited in the Declaration of the present application. A certified copy will be filed in due course.

Respectfully submitted,

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# Part I ECHONET Overview

Revision History

| | | | |
|---|---|---|---|
| •Version1.0 | March 18th | 2000 released | Open to consortium members |
| | July | 2000 | Open to the public |
| •Version1.01 | May 23rd | 2001 | Open to the public |
| (incl. additions and corrections to Version 1.0; Parts 1, 8, 9, and 10 are unchanged from Version 1.0) | | | |
| •Version2.00 | August 7th | 2001 | Open to consortium members |
| •Version2.01 | December 18th | 2001 | Open to consortium members |
| •Version2.10 Preview | December 28th | 2001 | Open to consortium members |
| •Version2.10 Draft | February 15th | 2002 | Open to consortium members |
| •Version2.10 | March 7th | 2002 | Open to consortium members |
| •Version2.11 | April 26th | 2002 | Open to consortium members |

(incl. corrections to Version 2.10 Draft and explanation of version numbering system)

## Contents

# Chapter1 Introduction

## 1.1 Envisioned Home Network Development

At the beginning of the 21st century, households are faced with a multitude of issues, including global environmental issues, such as protecting the ozone layer and reducing $CO_2$ output to prevent global warming, and the aging of society. Notably, there are calls for both industry and ordinary households to reduce $CO_2$ output by lowering energy consumption. Other issues include rising health care costs and the growing need for nursing care as society grows older.

At the same time, rapid advances in data and communications infrastructure, in the form of high-speed, high-bandwidth communications and multimedia capabilities, are making it easier than ever for households to connect to the outside world via such media as cable TV and the Internet.

Homes in the 21st century will need to be linked to society to provide safe, pleasant, and environmentally sound services, and this revolution is expected to create a host of business opportunities. Urgently needed are the creation of a communications infrastructure linking homes and society and enabling the realization of such services and the development and proliferation of an in-home communications infrastructure. to this end, a variety of technologies are being studied in Japan and abroad.

The in-home communications infrastructure, or "home network," will need to provide fast, high-bandwidth transmission of data and images. At the same time, it will have to incorporate a relatively low-speed/bandwidth/cost network that is compatible with conventional home appliances and equipment.

This network will enable the interconnection and systematic operation of a wide assortment of home appliances and controllers from different manufacturers. In addition to being more energy-efficient, homes featuring such networks will be safer, more comfortable, more user-friendly, and more environmentally sound and will be ready to meet the challenges of energy conservation, the aging of society, and home nursing care.

for example, to satisfy the growing need for energy conservation and load balancing, efficient energy utilization can be achieved through such features as user-friendly display of household energy use, automatic shut-off of appliances not in use, and automatic shifting of energy consumption to less expensive times of the day. This will provide fine-tuned energy savings and load-shifting automatically and create a new level of home comfort and convenience.

In addition, declining birth rates and the consequent graying of society are expected to increase the need to provide safety and security to households with seniors and to reduce the burden of home nursing care and health management. to meet this need, home networks could put occupants at ease and help them monitor their health by allowing easy retrieval of useful information in daily life. They could also be easily linked to the systems of hospitals and nursing care networks.

Further, the use of controls fine-tuned for common situations in daily life would enable the convenient, efficient operation of household appliances and equipment. When the house is unoccupied, for example, the system would switch to monitoring mode, automatically locking the doors and windows, turning off the air conditioner, and turning out the lights. On cold winter nights, the system would turn on the outdoor lights, close the curtains, and warm cold rooms in preparation for the occupants' return.

## 1.2 ECHONET Development Objectives

ECHONET (Energy Conservation and Homecare Network) was created to realize the kind of home network system described in the preceding pages, along with necessary related systems.

In the past, individual Japanese manufacturers have developed and marketed their own home automation systems based on the HBS (Home Bus System) standard. Such systems, however, have failed to achieve significant penetration in ordinary households.

This can be attributed to several factors. First, no currently available application systems offer acceptable cost performance. Also, the difficulty of developing network-compatible devices, which are much more complex than ordinary household appliances, has represented a heavy burden for developers. to these factors can be added the difficulty of connecting and maintaining networks of network-compatible devices, making their use in ordinary homes difficult, and the need for special wiring, which limited such systems to new homes.

Utilizing the results and experience of HBS development, ECHONET will provide the base technology for the development of next-generation home network systems capable of responding to the aforementioned changes in the social infrastructure, global environmental issues, and the aging of society.

ECHONET will develop: 1) a communications protocol for a reliable, low-cost home network that requires no new wiring and can be installed in existing homes; 2) multivendor-compatible home network equipment; 3) system models for use by individual vendors to facilitate development of application systems; 4) communications middleware and development support tools to mitigate the burden of developing equipment; and 5) application service-compatible middleware to facilitate development of applications required for energy conservation.

By reducing the burden of system and device development and facilitating equipment interconnection, we hope to promote the creation of attractive, low-cost application systems that more effectively utilize household appliances and devices.

## 1.3 ECHONET Aims

The ECHONET specifications were drawn up in response to the requirements of various groups, ranging from end users to product developers and system installers. They focus on the objectives listed below.

(1) Data transmission without special wiring

Transmission methods that do not require rewiring, and thus can be used in existing homes, such as ordinary power lines, wireless, and infrared, are used as the main transmission media. By taking advantage of the unique characteristics of these media, users can select the transmission media best suited to device and system characteristics. They can also develop systems without concern for the media via which the device will be connected. This assures great flexibility when approaching varying system needs in the future.

(2) Easy development of multivendor home systems

Home networks will become worthy of their name only when they make possible the trouble-free connection and operation of devices from various manufacturers. System models and specifications assure not only a common communications protocol between devices but also interconnectability at the system level. Thus, users can choose and install the device that best meets their needs from a range of ECHONET-compliant products from various vendors.

(3) Response to long lifetime and home system proliferation

Home network systems are characterized by the long lifetime (renewal cycle) of the appliances and devices comprising the network and continuous changes in system configuration driven by changes in family make-up, moves to new homes, and the addition of new devices or services. Widespread adoption of home network systems will also require a wide variety of connection methods, which will enable the incorporation of non-ECHONET-compliant devices, and an architecture that facilitates replacement of equipment and devices.

(4) Environment facilitating development of ECHONET-compliant devices

ECHONET stipulates the environment and interface conditions for the development of components that will support future development of major application systems. These components include hardware and software components to be shared by all devices (such as communications modules and software to be incorporated in each device) and required for energy management. This enables flexible development of ECHONET-related components and applications, freeing vendors to concentrate on the development of more fundamental features and performance. The end result will be the development of system products that are more useful for users.

(5) Easy system installation and device installation, replacement, and movement

Plug-and-play functionality makes it possible for anyone to set up the system and install, replace, and move system devices.

(6) Connectability and coexistence with other (AVC) systems

ECHONET specifies a scheme to enable low-cost connections with systems based on local standards in expectation of global adoption and connections with in-home image and data processing systems.

## 1.4 Envisioned Applications

As noted above, the first aim of ECHONET is to develop and promote adoption of a home network system using the electric appliances and equipment found in ordinary homes.

Fig. 1.1 shows envisioned applications for ECHONET. As shown in the diagram, ECHONET is designed for use with application systems containing the same devices and functions found in ordinary homes, including single-family dwellings, duplexes, apartment buildings, dormitories, and condominiums for senior citizens.

Also targeted are equipment systems for small office buildings and stores that are similar in terms of scale and system environment (cost, system lifetime, functions, wiring restrictions, etc.) and that have yet to make substantial use of building management systems or other facility management systems. Low-cost, easy-to-use subnetwork systems can be applied regardless of building size: entire-building systems for small buildings, or floor-by-floor systems in larger structures.

Systems designed primarily to monitor and control equipment are characterized by severe constraints on memory and other resources but have a low volume frequency of data exchange between individual devices. ECHONET can provide the foundation for a low-speed/capacity/cost network that meets these requirements.

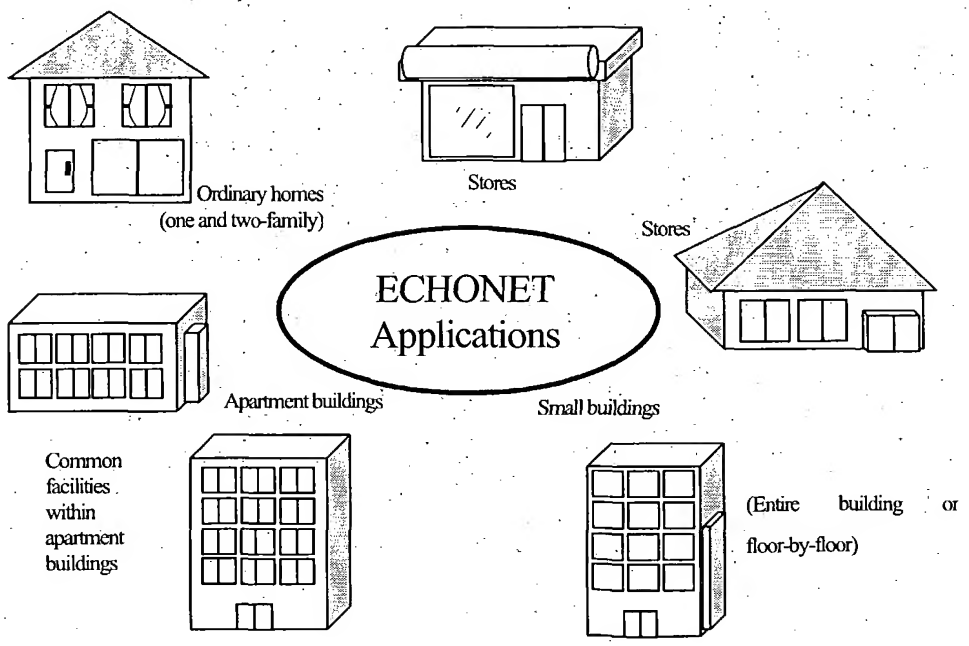


**Fig. 1.1 Envisioned applications for ECHONET**

## 1.5 ECHONET Characteristics

In accordance with the objectives described above, ECHONET was developed to provide the following characteristics:

(1) Support for various transmission media without rewiring

To facilitate adoption, installation, and use of the system in existing homes, ECHONET supports a wide range of transmission media, including both new and existing technologies, with a focus on those requiring no special wiring, such as ordinary power lines, wireless, and infrared. For power lines, which many expect to serve as core of the home network system, a reliable, high-speed power line communications protocol was developed that is compliant with Japanese power line regulations and noise environment. The ECHONET architecture also enables seamless handling of devices connected using various media, thereby facilitating systems development.

(2) Object-oriented modeling of system configuration

The specifications were kept clear and consistent by the use of object-oriented modeling of individual devices, interface methods (when using system functions), and the division of functions between devices. This guarantees interconnectivity from communications between individual devices to the system level and assures an integrated multivendor system.

(3) Open network architecture

To create devices that are system- and network-compliant, network connection functions were layered (in the communications layer structure), with specifications provided for the functions of each layer and for the inter-layer interface requirements. The result is an open network architecture enabling vendors to freely develop and commercialize ECHONET-related hardware components, software components, and development environments. This includes development and distribution of transmission media-level communications module components, development and distribution of ECHONET-compliant communications drivers and middleware, and creation of development environments that facilitate development of these software components and systems.

(4) API (Application Programming Interface)

Developing network-compatible functions has always represented a heavy burden for developers of device control software and application software (e.g., controllers and control units). In response, ECHONET will develop shared APIs that access the object models described above. By utilizing communication middleware that implements these APIs, application software developers will be able to develop network-compliant devices without having to concern themselves with communication protocols and transmission media differences.

(5) Plug-and-play functionality

Under ECHONET, systems will configure themselves automatically when a device is connected to the network, eliminating the need for system setup and installation by users, whether ordinary consumers or trained technicians. This is what is meant by plug-and-play functionality. ECHONET will provide a system enabling automatic allocation of communications addresses, automatic recognition of

device-identifying data, automatic recognition of device functions, and support for automatic setup of operating data, such as device installation location and inter-device control relationships.

(6) Service middleware

for each specific service application, the system will specify as service middleware the shared, basic functions required by that application. By utilizing service middleware and the relevant APIs, application software developers will find it easy to develop home system applications. ECHONET also defines service objects to enable access to these service middleware functions via the network. By utilizing the service objects of individual nodes, systems designers will be able to configure systems more efficiently.

# Chapter2 Definition of System Configuration

## 2.1 ECHONET System Architecture

This section will specify the ECHONET system make-up and system architecture. Figure 2.1 shows the ECHONET system architecture.

ECHONET incorporates into a system groups of devices with the same management of properties, security, and so on Therefore, the largest area that ECHONET can manage is referred to as a *domain*. A domain will be specified as the range of controlled resources (home equipment, appliances and consumer electronics, sensors, controllers, remote controls, etc.) present within the network range determined by ECHONET. In other words, a domain is a network range within which the transmission of data is logically guaranteed. A *system* is defined as that which performs communication and linked operations between devices and the controllers that monitor/control/operate them and between devices themselves. A system lies within one domain and does not extend over a number of domains. A domain includes one or more systems. Thus, the same device or controller can exist in more than one system. When connecting a system to another system lying outside the domain, an ECHONET gateway is used as an interface.

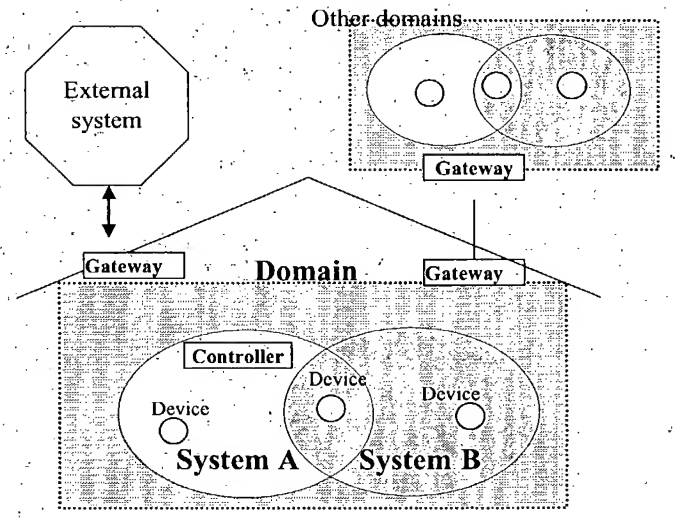


**Fig. 2.1 System architecture**

Concrete examples will be provided to help explain domain scope and the configuration of application systems. In reality, of course, each system designer will design systems in accordance with system size and the aforementioned criteria and will not be limited by these specifications.

| | |
|---|---|
| Single-family dwellings: | Entire structure |
| Dual-family dwellings: | Entire structure, or by family |
| Apartment buildings: | By individual units and shared areas. Depending on its purpose, an application system may be applied to an entire building. |
| Stores: | Entire structure |
| Buildings: | Entire structure, floor-by-floor, by type of facility to be managed, etc. depending on building size and type of management. |

As shown in Fig. 2.2, ECHONET Nodes (a node is defined as any device or controller connected to the network) in a system are able to exchange data freely and without distinction between controllers and devices and between devices themselves. Also, the system is defined without regard to lower-layer protocols, such as the network transmission media to be described later. The Fig. shows two application systems, A and B, within a domain; the devices within this domain may belong to one or both of these systems. In the example shown in the Fig., each system defines the controllers implementing the applications that manage (control, monitor, etc.) the devices connected to the system. Each device can communicate not only with the controllers in its system but also with other devices.

ECHONET specifies network architecture and system management based on these principles. It does not put constraints on product system architecture.

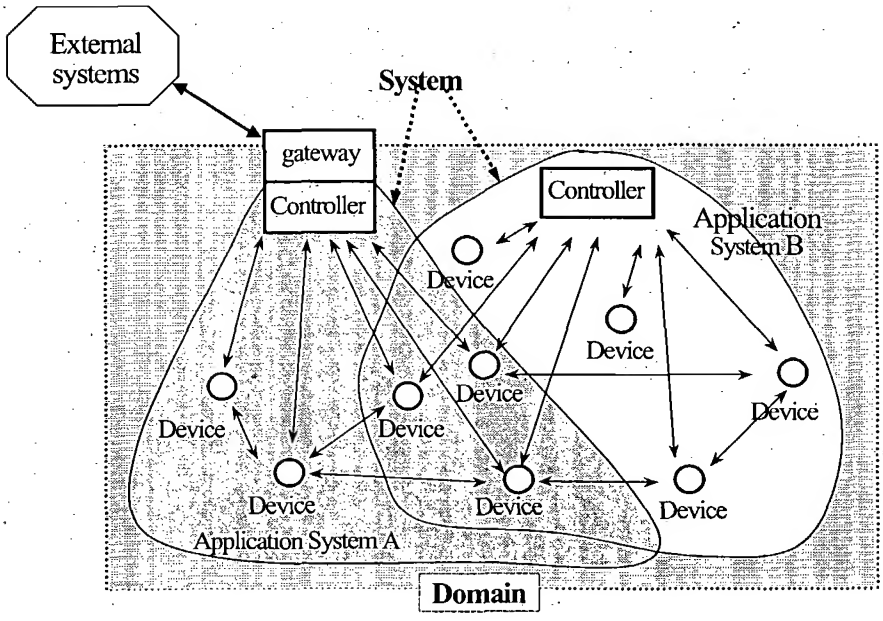


**Fig. 2.2 Domain scope and application system configuration (example)**

## 2.2 ECHONET Network Configuration

To enable the construction of optimal systems utilizing the unique characteristics of various transmission media, ECHONET allows use of numerous transmission media and protocols. The ECHONET network configuration model for the main transmission media are shown in Fig. 2.3. As described in the Fig., connections outside the domain are made using ECHONET gateways (GW). Connections between different protocols (i.e., different transmission media) within the same domain are made using ECHONET routers. The network whose boundaries are described by a single ECHONET router is called a subnet. The insertion of an ECHONET router enables the creation of different subnets with the same protocol. A domain's network configuration can be represented as a collection of subnets. In other words, a domain is the part of the configured network, including ECHONET routers, within which in-house data is communicated.

In a subnet, each node's identifier (Node ID) is defined and used as an ECHONET communications function (defined as an ECHONET Node) identifier unique within that subnet. Each subnet has its own unique subnet identifier (Net ID). An ECHONET address is defined as the subnet identifier plus the node identifier, and this pair becomes the ECHONET Node identifier unique within that domain.

ECHONET routers use the ECHONET address, which is unique for each ECHONET Node, to connect different transmission media seamlessly with respect to the system. This eliminates the need for an upper-layer level (i.e., ECHONET system architecture definitions) to recognize differences in transmission media, as noted above.

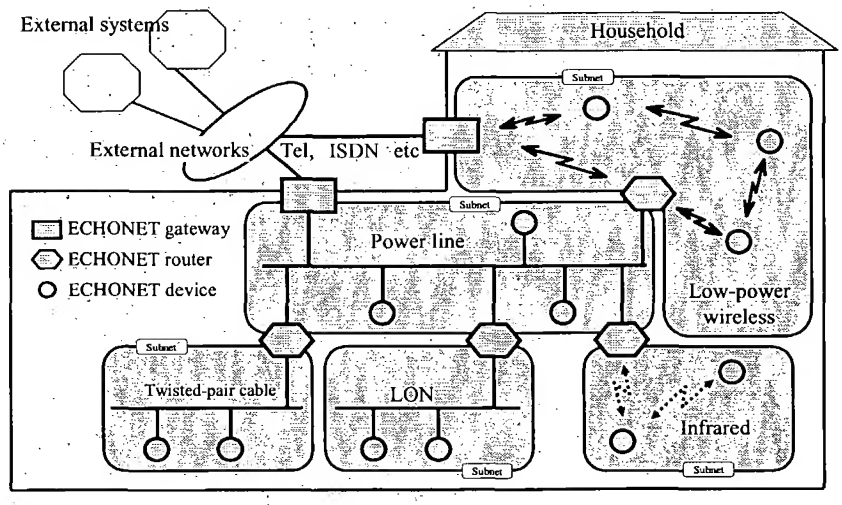


**Fig. 2.3 ECHONET network configuration model**

## 2.3 ECHONET Component Devices

This section describes the ECHONET component devices defined in the network configuration and system architecture above.

(1) ECHONET Node

A communications node based on the ECHONET specification. Within ECHONET, this refers to ECHONET communications functions identified uniquely by an ECHONET address. This term makes no distinctions between the application functions of the node and is used when describing the node's functions as a single communications terminal in ECHONET.

(2) ECHONET device

An ECHONET Node with ECHONET-compatible communications interface and system-compliant functions; may include home equipment, home appliances and consumer electronics, and building or store facilities (e.g., lighting, air conditioning, refrigeration, electrical power facilities, ordinary white goods, sensors, and actuators). Also, an ECHONET Node acting as a controller, such as central control devices that monitor, control, or operate these nodes, or control units (e.g., remote control units).

(3) Device adapter

An adapter designed to connect devices without communications interfaces for ECHONET-specified transmission media to ECHONET during the early stages of adoption. Interface specifications for devices and ECHONET device adapters will be based on the ECHONET device adapter interface specification to be provided separately.

(4) ECHONET gateway

Connects ECHONET domains to external systems, including other ECHONET domains. A number of ECHONET gateways may exist within the same domain, depending on differences in the external systems to be connected to.

(5) ECHONET router

An ECHONET Node designed to connect an ECHONET subnet to another ECHONET subnet. It can be used to connect subnets with different lower-layer protocols (i.e., in cases of different transmission media or different media protocols) or to partition a single protocol into a number of subnets.

## 2.4 Connections to External Networks and Systems

In homes, buildings, and stores, a variety of external networks exist, including outside networks for connecting to hospital systems, etc., and those designed to transmit image and other data on other in-home networks. ECHONET, which is positioned as a field network, views these networks as being outside the domain and connects to them at the application level via ECHONET gateways. When directly sending and receiving messages to and from external systems, protocol conversion is performed at the application level. Henceforth, networks outside the domain will be referred to as external networks. External applications will be referred to as external systems.

In the ECHONET specifications for connection with external systems, the concept of defining object models for each specific application based on user or vendor needs is being studied from the standpoint of how to present the in-house network to external systems. These object models are called gateway service objects, and the middleware that implements their functions is referred to as gateway service middleware. These definitions have two objectives:

・When developing external systems, to enable use of the same model for ECHONET adoption system, independent of in-house vendors.

・When developing in-house systems, to enable development of gateways independent of the vendors of external systems handling the same services.

Based on this concept, users can freely choose and arrange external or in-house system vendors. Also, ECHONET does not specify a unique domain identifier. It is the external system that seeks to identify specific ECHONET domains, and therefore external systems are responsible for adopting methods to identify each domain.

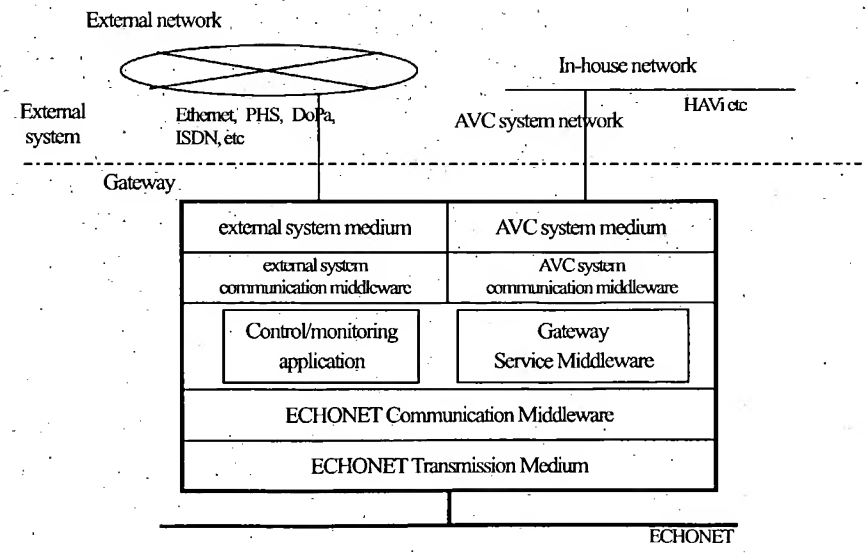


**Fig. 2.4 Connection to xternal systems**

# Chapter3 ECHONET Communication Layer Configuration

## 3.1 Overview of ECHONET Communication Layer Configuration

The ECHONET device communication layer can be broadly divided into three layers: Application Software, Communication Middleware, and Lower-layer Communication Software. The ECHONET specification will provide specifications for Communication Middleware and for Lower-layer Communication Software.

- Application Software

  Application Software can be broadly divided into software that provides remote control of devices connected to the system and software that realizes the hardware functions of such individual devices as air conditioners and refrigerators.

- ECHONET Communication Middleware

  ECHONET Communication Middleware is provided between the Application Software and the Lower-layer Communication Software and processes communication in accordance with the ECHONET communication protocol. In other words, it realizes the principal features of ECHONET.

- Lower-layer Communication Software

  Lower-layer Communication Software handles the communication protocol processing unique to each Transmission Medium, such as power line, wireless, and infrared. It is primarily responsible for processing communications corresponding to Layers 1 and 2 in the OSI reference model. Lower-layer Communication Software is defined for each supported communication protocol. At present, Version 2.10 of the ECHONET specification defines Lower-layer Communication Software for the following protocols: power line communication protocol, wireless communication protocol, infrared communication protocol (IrDA Control), extended HBS protocol, and LonTalk protocol.

Fig. 3.1 shows a conceptual view of the ECHONET communication layer configuration.

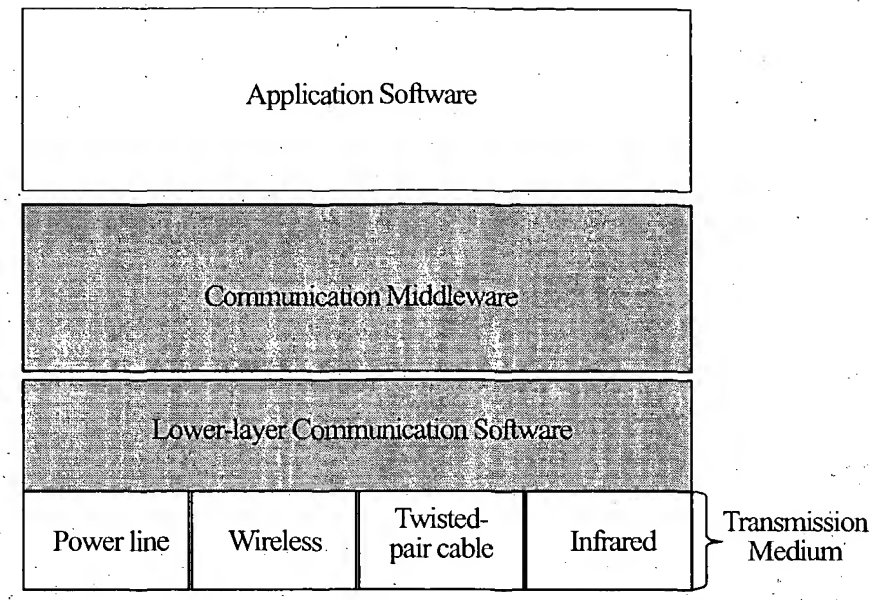


**Fig. 3.1 Overview of ECHONET communication layer configuration**

## 3.2 Communication Layer Elements

Fig. 3.2 shows the overall communication layer configuration further divided into a number of processing blocks.

ECHONET Communication Middleware consists of the ECHONET Communication Processing Block, the Protocol Difference Absorption Processing Block, and Device Objects. Fig. 3.2 also shows the following communication layer configuration block interfaces: Basic APIs (Application Programming Interfaces), Service APIs, Common Lower-layer Communication Interface, and Individual Lower-layer Communication Interfaces. Finally, Service Middleware, which acts as a shared library to assist application software processing, is presented as Service Objects.

Of the processing blocks and processing block interfaces shown in Fig. 3.2, ECHONET specifies the shaded portions.

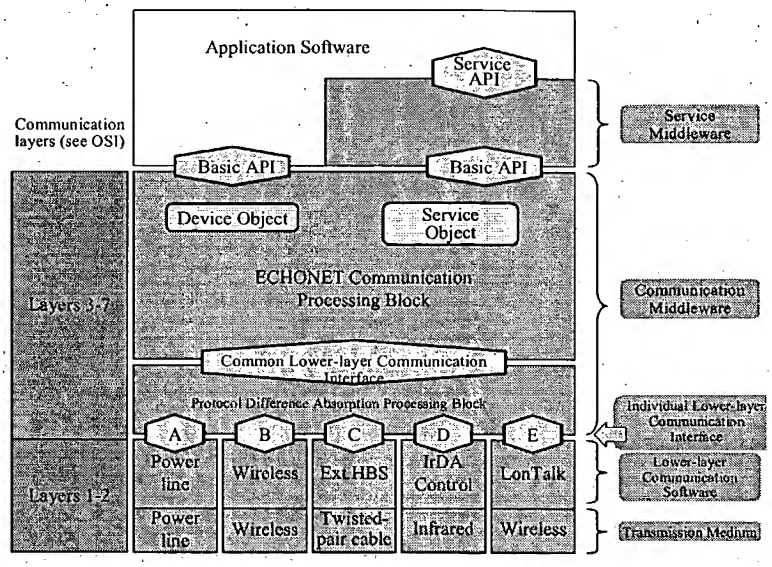


**Fig. 3.2 ECHONET communication layer configuration**

### 3.2.1 Service Middleware

As systems becomes more complex and applications undertake more sophisticated processing, the burden of developing application software is greatly reduced by APIs, which provide common processes in the form, for example, of libraries. If a certain application is indicated, many more specialized processes can also be shared. Service Middleware is the software that defines the shared and basic processes for a given application and provides the APIs to enable use of these functions by the application software. Further, ECHONET defines Service Objects as objects that enable use of these functions and settings by the network. Service Middleware includes linked functions that can be applied to a variety of applications, scheduling functions, gateway functions (which establish connections with external networks), and functions designed for a specific application, such as home EMS (energy management system) applications, automatic electric and gas meter-reading applications, and device maintenance applications. ECHONET will provide specifications for Service Middleware going forward while extending the variety of available applications.

### 3.2.2 ECHONET Communication Processing Block

The ECHONET Communication Processing Block is responsible for processing the communication protocols needed to facilitate processing when application software is remotely controlling or monitoring a device in an equipment system; for storing the data needed to process communication protocols; and for managing device condition and other data. In other words, this block performs communication processing for accessing objects, such as the Device Objects of other devices. ECHONET specifies this communication protocol. of the data stored by this block, the data and access procedures that are disclosed to other devices are expressed as objects and specified as ECHONET object definitions. Also specified are routing processing and address management.

### 3.2.3 Protocol Difference Absorption Processing Block

The purpose of this block is to integrate networks consisting of numerous Lower-layer Communication Protocols and Transmission Media, such as power line, wireless, LonTalk, and infrared, and to present them as a single network. When aiming towards a system configuration that enables selection of Transmission Media, such as power line or wireless, depending upon the application, or that enables joint use of such media, the need to consider complex network configurations and differences in address and message size for each Transmission Medium becomes a tremendous burden during development work. ECHONET Communication Middleware presents such systems to applications as a single network. This facilitates the development of application software, which need not take into account complex network configurations.

ECHONET specifies address conversion methods, communication conversion methods, and message splitting and assembly methods performed in the Protocol Difference Absorption Processing Block.

### 3.2.4 Device Object

The Device Object is a logical model of the data stored by white goods and other equipment, such as sensors, air conditioners, and refrigerators, or of the control items which can be operated remotely. It provides an integrated interface format for remote control. Because the Device Object is specified separately for each type of device, similar devices from different manufacturers, as long as they belong to the same class, can be remotely controlled using the same operating sequence. Specifically, the data and control properties for each device will be specified as Device Object object properties, and the method of manipulating them (settings and reference) will also be specified.

Device Objects are defined using the HK (House Keeping) commands specified in JEM-1439.

While JEM-1439 focuses mainly on household devices, ECHONET will also specify devices for small buildings and stores.

### 3.2.5 Transmission Medium and Lower-Layer Communication Software

ECHONET will specify communication protocol for power line, low-power wireless, infrared, LonTalk, and other transmission media. In the case of LonTalk and infrared (IrDA Control), existing

protocols will be used, but ECHONET will specify how these protocols are to be incorporated (i.e., which communication functions are to be used in what way). Lower-layer Communication Software processes the communication protocols unique to each Transmission Medium; primarily, this processing corresponds to Layers 1 and 2 of the OSI reference model. Currently, Version 2.10 of the ECHONET specification defines the following Lower-layer Communication Software protocols: power line communication, low-power wireless communication, IrDA (infrared) control, extended HBS (twisted-pair cable), and LonTalk (low-power wireless).

### 3.2.6 API

Application software uses APIs to access other devices and to access data stored by the ECHONET Communication Middleware of the Self-device. By specifying APIs, ECHONET aims to improve the portability of application software.

As shown in Fig. 3.2, there are two types of APIs: Basic API and Service API.

(1) Basic API

Basic APIs are designed to let application software utilize basic ECHONET functions, and in general only these APIs need to be used. Basic APIs mainly submit processing requests for the management of ECHONET communications (start, stop, etc.) and for ECHONET communication transmission and reception functions. They are called when accessing a remote device (and particularly when accessing Device Objects stored in a remote device).

Basic APIs are also used by application software that remotely controls other devices, primarily in controllers, etc., and by device control applications which perform Self-device hardware control in air conditioners, refrigerators, sensors, and so on. The ECHONET specifications allow the use of basic APIs in both situations.

(2) Service API

Service APIs are an interface enabling application software to use Service Middleware functions.

Note also that Service Middleware uses Basic APIs when utilizing ECHONET Communication Middleware functions during internal processing.

### 3.2.7 Common Lower-Layer Communication Interface

This interface enables all types of Lower-layer Communication Software to be seen by ECHONET Communication Middleware as having common specifications. It is used when using the Lower-layer Communication Software functions in a format in which Lower-layer Communication Software differences have been absorbed by the Protocol Difference Absorption Processing Block.

The purpose for specifying this interface is to enable quick application of the ECHONET specifications to new Lower-layer Communication Software and to prevent impact on other component elements. These objectives are achieved by using a Common Lower-layer Communication Interface to specify the interface to be protected when modeling ECHONET Communication Middleware processing and incorporating new Lower-layer Communication Software in the ECHONET specifications.

### 3.2.8 Individual Lower-Layer Communication Interface

This is an interface between the Lower-layer Communication Software and the Protocol Difference Absorption Processing block of the Communication Middleware.

The purpose for specifying this interface is to clarify the usage of communication protocols and Lower-layer Communication Software and to enable the development of devices that can be interconnected, regardless of manufacturer, using this specification and based on ECHONET standards. This includes cases in which the Lower-layer Communication Software communication protocol uses existing non-ECHONET standards (e.g., IrDA Control) or in which off-the-shelf Lower-layer Communication Software (e.g., LonWorks communication processing software) is to be used.

# Chapter4 Connection of Devices to ECHONET Networks

## 4.1 Implementation of ECHONET Standard in Devices

The decision of which part of the ECHONET specifications to use in a product will depend on its positioning in the communication layer and is left to the user. However, by using the same procedure for communications between devices, it is possible for devices to exchange data. Interconnectivity between devices is also needed to prevent an adverse impact on the processing of other devices.

ECHONET allows connection to the ECHONET network via ECHONET device adapters. To achieve device interconnectivity, the division of functions between ECHONET device adapters and the devices themselves must be clearly stated.

This section will explain the various types of ECHONET devices and ECHONET device adapters as well as the methods available for connecting devices to an ECHONET network.

## 4.2 ECHONET Device Types

ECHONET defines and specifies two types of ECHONET devices based on the content of the supported ECHONET Communication Middleware. ECHONET device developers will need to select one of the two types and design their devices in accordance with specifications for the ECHONET communication layer configuration block (see Table 4.1) to be implemented in the device.

(1) Full ECHONET device

(2) Flex ECHONET device

(1)Full ECHONET device (Full_Device)

A Full ECHONET device has a communication interface specified by ECHONET, such as power line communication, and can connect to an ECHONET system on a stand-alone basis.

(2)Flex ECHONET device (Flex_Device)

A Flex ECHONET device incorporates application software and ECHONET Communication Middleware (ECHONET Communication Processing Block), which stands above the Common Lower-layer Communication Interface, and connects to an ECHONET system using a device adapter, which processes communication below the Common Lower-layer Communication Interface.

Table 4.1 shows the relationship between the ECHONET communication layer configuration block and the two types of devices described above.

**Table 4.1 ECHONET communications layer configuration block and ECHONET device types**

| | Full_Device | Flex_Device |
|---|---|---|
| Application Software | ○ | ○ |
| Service Middleware | — | — |
| Device Object | ○ | ○ |
| ECHONET Communication Processing Block | ○ | ○ |
| Protocol Difference Absorption Processing Block | ○ | — |
| Lower-layer Communication Software | ○ | — |
| Adapter Communication Software | — | ○ |

Note: ○: required, —: not specified

## 4.3 Adapters for Connection to ECHONET Networks

A Flex ECHONET device is connected to an ECHONET network using a device adapter. A Full ECHONET device can connect to the network on a stand-alone basis, but a device adapter becomes necessary when the network transmission medium is not supported by the device. In some cases, existing devices without an ECHONET communication interface can also connect to an ECHONET network using a dedicated device adapter. In this way, device adapters vary with the type of device to be connected. Two types of device adapters can be connected to Full and Flex ECHONET devices, and these are described below. Note that ECHONET currently specifies only the first type of adapter (ECHONET device adapter).

(1) ECHONET device adapter

(2) Communication conversion device adapter

(1) ECHONET device adapter

Connecting a Flex ECHONET device with an ECHONET device adapter enables connection to an ECHONET system through the addition of Lower-layer Communication Software.

(2) Communication conversion device adapter

Connecting a Full ECHONET device with a device adapter enables connection to an ECHONET system using a different Lower-layer Communication protocol.

Table 4.2 shows the relationship between the ECHONET communication layer configuration block and the two ECHONET device adapter types.

**Table 4.2 ECHONET communications layer configuration block and ECHONET device adapter types**

| | Transmission medium addition device adapter | Communications conversion device adapter |
|---|---|---|
| Application Software | — | — |
| Service Middleware | — | — |
| Device Object | — | — |
| ECHONET Communication Processing Block | — | — |
| Protocol Difference Absorption Processing Block | ○ | ○ |
| Lower-layer Communication Software | ○ | ○ |
| Adapter Communication Software | ○ | — |

Note: ○: required, —: not specified

## 4.4 Connection formats

The format for connecting a device to an ECHONET network varies with the type of device. There are four formats, as shown below (see Fig. 4.1).

Format 1: Direct connection of a Full ECHONET device to the network

Format 2: Connection of a Flex ECHONET device to the network using a device adapter

Format 3: Connection of a Full ECHONET device to the network using a device adapter

Format 4: Connection of an existing device to the network using an adapter

Of the connection formats shown in Fig. 4.1, ECHONET currently specifies only the device adapter in Format 2.

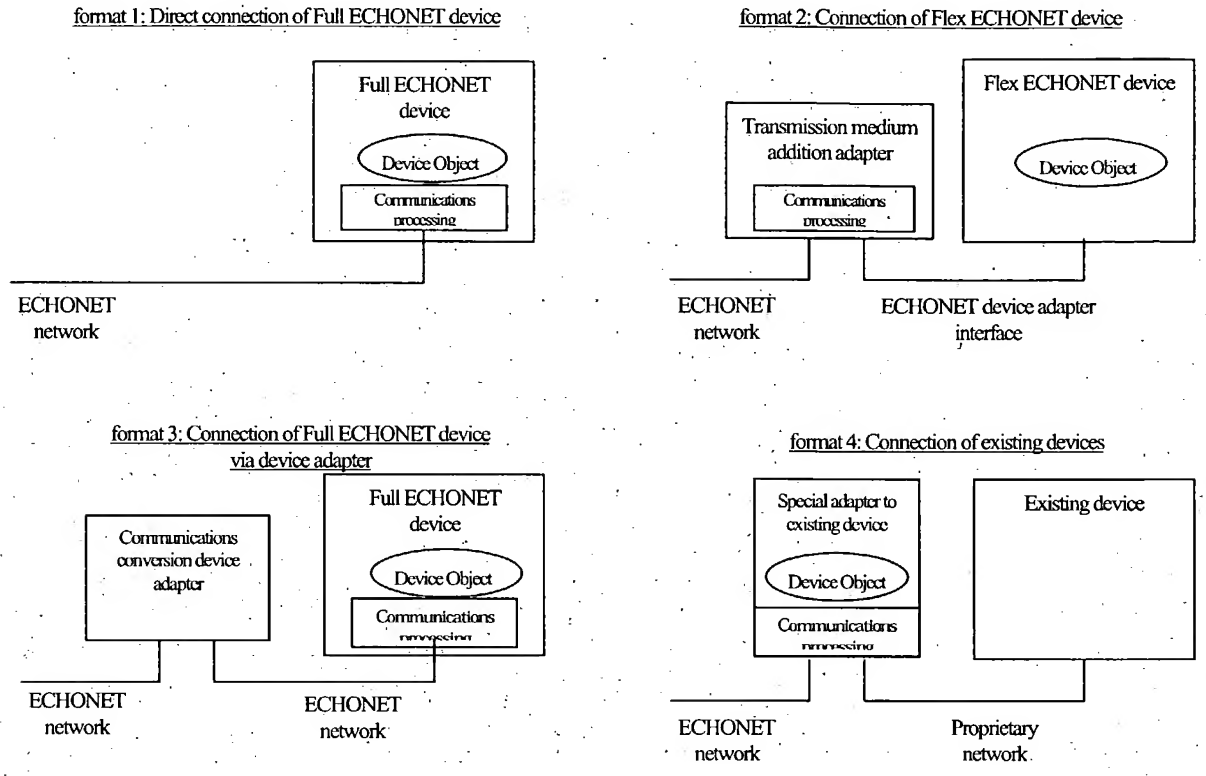


**Fig. 4.1 Device adapter and device combinations**

The "existing device" shown in format 4 above would have a proprietary communications interface that is not specified by ECHONET (e.g., a one way infrared communication interface) and would connect to an ECHONET system via an adapter with ECHONET communication functions. ECHONET does not specify an adapter designed to work with existing device.

# Chapter5 Structure of ECHONET Specifications and Intended Readership

## 5.1 Structure of Specifications

The ECHONET specifications are structured into the Volumes shown below.

Part I ECHONET Overview

ECHONET objectives, characteristics, overall architecture, definition of basic terminology, and ECHONET device types.

Part II ECHONET Communication Middleware Specifications

Specifications for message format, communication address, protocol processing, Device Object definition, startup sequence, routing processing, etc., in the ECHONET Communication Middleware.

Part III ECHONET Transmission Medium and Lower-Layer Communication Software Specifications

Communication protocol specifications for Lower-layer Communication Software, primarily from the viewpoint of Layers 1 and 2.

Part IV ECHONET Basic API Specifications

Basic API specifications, which serve as interface specifications for the development of ECHONET-based application software.

Part V ECHONET Common Lower-Layer Communication Interface Specifications

Specifications for the communication interface, which is positioned between the Protocol Difference Absorption Processing Block and the ECHONET Communication Processing Block of the Communication Middleware.

Part VI ECHONET Individual Lower-Layer Communication Interface Specifications

Specifications for the Individual Lower-layer Communication Interface, which serves as the interface with ECHONET Communication Middleware for each Lower-layer Communication protocol.

Part VII ECHONET Communication Device Specifications

Specifications for the device adapter interface and hardware specifications for when a device is viewed as communications device hardware.

Part VIII ECHONET Service Middleware Specifications

Processing content and Service Object definition specifications for individual ECHONET Service Middleware.

Part IX ECHONET Gateway Specifications

Software specifications for ECHONET gateway as ECHONET Service Middleware.

Part X ECHONET System Design Guidelines

Guidelines to be used in designing an ECHONET system from standpoint of system planning, design, operation, and maintenance.

## 5.2 Intended Readership

These specifications were designed to be read by developers of ECHONET devices, device adapters, Lower-layer Communication protocols, application software, and Service Middleware and by system developers and managers. Following is a suggestion of the Parts that readers in each group should focus on.

(1) ECHONET device developers

ECHONET device developers should read all Volumes, but particularly important are the sections regarding the ECHONET communications layer configuration components being supervised by the developer (including surrounding interfaces).

(2) Device adapter developers

Readers in this group should focus on *Part VII ECHONET Communication Device Specifications* and also read the following Volumes: *Part II ECHONET Communication Middleware Specifications*, *Part III ECHONET Transmission Medium and Lower-Layer Communication Software Specifications*, *Part V ECHONET Common Lower-Layer Communication Interface Specifications*, and *VI ECHONET Individual Lower-Layer Communication Interface Specifications*.

(3) Lower-layer Communication protocol developers

Members of this group should read the following Volumes: *Part II ECHONET Communication Middleware Specifications* (especially the section on the Protocol Difference Absorption Processing Block), *Part III ECHONET Transmission Medium and Lower-Layer Communication Software Specifications*, *Part V ECHONET Common Lower-Layer Communication Interface Specifications*, and *Part VI ECHONET Individual Lower-Layer Communication Interface Specifications*.

(4) Application software developers

Readers in this group should focus on *Part IV ECHONET Basic API Specifications* and refer to *Part II ECHONET Communication Middleware Specifications* for an understanding of protocol behavior and control items for devices to be controlled using APIs. Also, developers of controller-based system applications should read *Part X ECHONET System Design Guidelines*.

(5) Service Middleware developers

Readers in this group should focus on *Part IV ECHONET Basic API Specifications* and also refer to *Part VIII ECHONET Service Middleware Specifications* for the Service Middleware specification format described therein. They should also read *Part II ECHONET Communication Middleware Specifications* for an understanding of protocol behavior and control items for devices to be controlled using APIs.

(6) System developers and managers

Members of this group should first read *Part X ECHONET System Design Guidelines* and then refer to *Part II ECHONET Communication Middleware Specifications* for an understanding of protocol behavior and control items for devices to be controlled using APIs. They should also read *Part VII ECHONET Communication Device Specifications* and *Part IV ECHONET Basic API Specifications*.

## 5.3 Version numbering system

Since Version 1.01 of the ECHONET specification, the following numbering system has been used. Following is a description of the system using as an example Version 2.10.